**Investigation for Evaluating Groundwater Background at Homestake
National Priority Listing Site, Grants, New Mexico**

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Summary of Work

The purpose of this investigation is to provide an independent review of available data to evaluate appropriate groundwater background concentrations of contaminants of concern for the Homestake Mining Company National Priority Listing (NPL) Site (Homestake NPL Site). The alluvium and three Chinle Formation aquifers (upper, middle, and lower) are the aquifers of concern at the Homestake NPL site. The following work elements are included this investigation:

- Perform additional geochemical modeling (PHREEQC) on groundwater data from Well DD completed in the alluvium (and other upgradient wells as appropriate) to determine the source of the high uranium concentrations (i.e., natural or anthropogenic);

- Review the groundwater background database for the alluvium and Chinle Formation aquifers provided by Homestake Mining Company, including review of QA/QC parameters and analytical methods to ensure data integrity and technical defensibility. This is the same database used by Drs. Tom Myers and Ann Maest to calculate selenium and uranium values;

- Independently determine which wells completed in the alluvium and Chinle Formation aquifers and geochemical or water quality data are appropriate for use in background calculations. This may include identification of new wells and data not previously used by various parties to evaluate background, or removal from consideration wells and data that were previously used; and

- Recalculate new background values for selenium, uranium, and other contaminants using the identified wells and appropriate data and information and ProUCL 5.0.00 software available from the United States Environmental Protection Agency (EPA 2013).

Introduction

Groundwater background analysis and determination are essential components of site investigations, remediation technologies, and monitoring programs conducted at the Homestake Mining Company National Priority Listing (NPL) site (Homestake NPL Site), Grants, New Mexico. Available groundwater quality data collected by Homestake Mining

Company relevant to background chemistry in the alluvium and Chinle Formation aquifers will be reviewed and assessed by NMED and the EPA during this investigation. Alluvial groundwater not impacted from previous mine water discharges and tailings leachate released to Arroyo de Puerto north of the Homestake NPL Site is considered by NMED and EPA to be representative of natural background to the site. Mining/milling-sourced recharge of alluvial groundwater may actually be the source of impacts to the alluvial system upgradient from the Homestake NPL Site. Additional information on this groundwater background investigation proposed in this scope of work is provided in Appendix A.

Approach and Methodology
The hydrogeological and geochemical characteristics of alluvium and Chinle Formation groundwater upgradient, onsite, and downgradient from the former uranium mill site will be evaluated to accomplish the following:

(1) Confirm the appropriateness of a list of chemicals of potential concern (COPCs), including chloride, molybdenum, nitrate, ^{226}Ra, ^{228}Ra, selenium, sulfate, ^{230}Th, total dissolved solids, uranium, and vanadium, developed by the U. S. Nuclear Regulatory Commission (NRC, 2006), and

(2) Evaluate hydrogeological (groundwater flow paths) and geochemical conditions that affect the spatial and temporal distributions of COPCs and their concentrations in alluvial and Chinle Formation groundwater.

The COPCs with Groundwater Protection Standards (GWPS) established by the NRC (2006) were based on background concentrations in the alluvium, the three Chinle Formation aquifers and a mixing zone representing the mixture of alluvial and Chinle Formation groundwaters along subcrop areas (Mixing Zone). The GWPS may contain a component of historic mine discharge water originally released to Arroyo del Puerto and San Mateo Creek. All information and data needed for the analysis of these COPCs will be assembled and a four-step process will be used consisting of:

(1) Identify all actual or suspected on-site and upgradient COCP sources, and evaluate hydrogeological characteristics of the site and the appropriateness of associated data to be used for background determinations based on such characteristics.

(2) Evaluate the geochemical characteristics of alluvial and Chinle Formation groundwater and available information on the aquifer matrix, including reactive minerals/amorphous solids (calcite, gypsum, ferric (oxy)hydroxide, and smectite) within areas deemed appropriate for background utilized by Homestake Mining Company.

(3) Evaluate analytical methods, detection limits, quality control, quality assurance, and identify analytical laboratories that provide groundwater chemistry data to assess the validity of the data provided by Homestake Mining Company.

(4) Construct hydrological and geochemical plots and graphs to evaluate concentrations of the target COPCs with respect to space and time for each background-monitoring well utilized by Homestake Mining Company. This will be done to assess the suitability of the well location to represent natural background conditions, which are not impacted by historic mine discharge water released to Arroyo del Puerto and San Mateo Creek or impacted by discharges from the Homestake tailings impoundment. Well locations identified to represent non-impacted regions of the alluvial and Chinle Formation aquifers will be used to provide background groundwater data appropriate for recalculating natural groundwater background quality for the Homestake NPL Site.

<u>Current Background Monitoring Wells</u>
Homestake Mining Company currently used the following monitoring wells completed in the alluvium and Chinle Formation to determine background in 2006.

Alluvium: Monitoring wells DD, ND, P, P1, P2, P3, P4, Q, and R.

Chinle Formation Monitoring Wells: CW9, CW10, CW15, CW17, CW24, WR25, CW35, CW36, CW37, CW39, CW43, CW50, and CW52.

<u>Statistical Analysis of Groundwater Background</u>
A comparative analysis consisting of various statistical testing methods will be conducted to statistically derive site-specific background values for the alluvium, Chinle Formation aquifers, and Mixing Zones. Based on the complex site hydrogeology, there may be at least eight separate groundwater zones that will require analysis for background. They are the alluvium, Upper Chinle, Upper Chinle Mixing Zone, Middle Chinle, Middle Chinle Mixing Zone, Lower Chinle, and Lower Chinle Mixing Zone. There may be additional groundwater zones requiring separate statistical background analysis due to the separation of Chinle Formation aquifers by geologic faults and specific groundwater flow paths and recharge areas of alluvial groundwater. The background values shall be calculated for each of these groundwater zones using the revised well data sets established to represent the non-impacted regions of the alluvial and Chinle Formation aquifers. The computer program ProUCL5.0 developed by EPA (2013, 2015) is available to calculate the site-specific background concentrations. The ProUCL5.1.002 software will be used to calculate the background concentrations , consistent with EPA guidance (2009, 2013, 2015).

Once the site-specific background concentrations are statistically derived, EPA will compare the background concentrations to federal drinking water and state groundwater standards. If concentrations of background chemicals are below drinking water and groundwater standards, then the standards may be deemed appropriate remediation goals by EPA in any future decision-making process under the Comprehensive Environmental Recovery, Compensation, and Liability Act (CERCLA) for the Homestake NPL site groundwater remedy. In the record of decision, EPA would determine if such standards are applicable or relevant and appropriate requirements

(ARARs) that must be achieved or waived under CERCLA. If background concentrations in the alluvium and Chinle Formation are above the drinking water or groundwater standards, then EPA would consider selecting background concentrations as the groundwater remediation goals in the CERCLA decision-making process.

<u>Appendix A</u>
Geochemical data and information are required to rigorously determine groundwater background in the alluvium and Chinle Formation that are not impacted by historic mine discharges released to Arroyo del Puerto since the early 1960s north of the Homestake NPL Site. The Phase 2 investigation conducted by U. S. EPA and Weston Solutions, Inc. (Weston Solutions, Inc. 2018) will provide geochemical and hydrogeological data and information relevant to this investigation. All available data and information that are appropriate, relevant, and technically defensible and will be compiled and incorporated into an updated groundwater background dataset. Following dataset compilation, the reported chemical concentrations will be utilized in the ProUCL5.1.002 statistical analysis for deriving site-specific background concentrations for each of the eight separate groundwater zones.

EPA's 2018 Phase 2 Groundwater Investigation Report for the San Mateo Creek Basin (Weston Solutions, Inc. 2018) discusses a very large volume of mine discharge water that recharged the alluvial aquifer in the upper and lower floodplain of the basin. Groundwater impacts may also be associated with the geochemical interactions occurring between these mining/milling waters and the alluvial sediments. For example, if a naturally occurring chemical adsorbs onto alluvial sediments or forms a reactive precipitate that is subsequently released to groundwater as a result of reacting with groundwater sourced from mining and milling activities, then that chemical is anthropogenic and should not be included as a background constituent.

The following assumptions and approaches presented by Maest (2019) will be followed to evaluate groundwater background in the alluvium and Chinle Formation as part of this investigation:

- Geochemical and field hydraulic data in the Homestake database are an accurate representation of original data provided from analytical laboratories and field measurements, the database was checked for quality control, and any transcription errors associated with analytical results were corrected by Homestake Mining Company.

- The aquifer designations of monitoring wells presented by Arcadis (2019) and NRC (2006) are correct.

- The designations of monitoring wells in the three Chinle mixing and non-mixing zones (NRC, 2006, Table 3) are correct.

- None of the groundwater-quality data contained in the Homestake database are lab-rejected data, which are usually designated with an "R" qualifier (a column in the archived database called Lab Code has "R" entries, but the codes are not defined in the Access database). Rejected data should not be used in the groundwater background evaluation.

- Groundwater background data defined by NMED and EPA are representative of natural conditions absent effects from uranium mining and milling, including discharges sourced from Arroyo del Puerto north of Homestake NPL site.

- Groundwater quality data for the alluvium and Chinle Formation showing a consistent increase or decrease in concentration (non-steady state condition) over time and across seasons or years for the identified COPCs is an indication of mine/mill-influenced water and should not be used for the background evaluation.

- Groundwater quality samples collected from monitoring wells in identified contaminant plumes in the alluvial aquifer for a given time period have been affected by mine discharge and tailings leachate and should not be used for the background evaluation.

- Analytical results obtained from monitoring wells before chemical concentrations began to increase can be used for groundwater background evaluation.

- Analytical results obtained from monitoring wells showing increasing concentrations of chemical A, for example uranium, but not showing increasing concentrations of another chemical B, for example selenium, can be used for groundwater background chemical B. The sources and relative mobility of the two chemicals in groundwater control when the contaminant shows up at a given monitoring well. For example, the selenium plume may have reached a location before the uranium plume because uranium may be more reactive in the alluvial aquifer (Arcadis, 2018, p. 23).

- Mixing of historic mine discharge water and tailings leachate, sourced from Arroyo del Puerto, with native alluvial groundwater, from monitoring well DD (west) to monitoring well ND (east), most likely influences groundwater chemistry immediately north of the large tailings pile (LTP).

- There are very few alluvial groundwater samples that are not affected from mining related discharge. In most cases, sulfate, calcium, and other major cations and anions and trace elements (uranium) are often elevated because of different attenuation properties controlling rate of transport in the alluvial aquifer.

Available groundwater background data for the Homestake NPL Site will be compiled and evaluated for statistical analysis of groundwater background quality for the alluvium and Chinle Formation. The goal of the statistical analysis is to re-characterize background-groundwater quality in a manner such that federal and state regulators can make future decisions on the appropriateness of using background concentrations as remediation goals in lieu of promulgated federal or state drinking water and groundwater standards. Specifically, CERCLA remediation goals that are based on background water quality may apply at the Homestake NPL Site when background concentrations of contaminants exceed federal drinking water standards and state groundwater standards.

Background evaluations, groundwater monitoring, exposure and risk management and cleanup decisions in support of the (CERCLA) and Resource Conservation and Recovery Act (RCRA) site projects of EPA are often derived based upon the various test statistics, for example Shapiro-Wilk test, t-test, Wilcoxon-Mann-Whitney (WMW) test, analysis of variance [ANOVA], Mann-Kendall [MK] test, and decision statistics including upper confidence limits (UCLs) of mean, upper prediction limits (UPLs), and upper tolerance limits (UTLs). The EPA's ProUCL v.5.1.002 (EPA 2013, 2015) statistical software is acceptable software due to its ease of use, excellent documentation, wide acceptance, and free availability. The software is available for download at

http://www.epa.gov/osp/hstl/tsc/software.htm

ProUCL software has been upgraded and enhanced over the years to include many graphical tools and statistical methods described in the various EPA guidance documents. Several statistically rigorous methods, for example for data sets with non-detects (NDs) not easily available in the existing guidance documents and in the environmental literature are also available in ProUCL version 5.1.002 (ProUCL 5.1).

ProUCL 5.1.002 (EPA 2013, 2015) has graphical, estimation, and hypotheses testing methods for uncensored-full data sets and for left-censored data sets consisting of NDs observations with multiple detection limits (DLs) or reporting limits (RLs). In addition to computing general statistics, ProUCL 5.1.002 has goodness-of-fit (GOF) tests for normal, lognormal and gamma distributions, parametric and nonparametric methods including bootstrap methods for skewed data sets to compute various decision making statistics such as UCLs of mean (EPA 2002a), percentiles, UPLs for a certain number of future observations (e.g., k with k=1, 2, 3 etc. UPLs for mean of future k (≥1) observations, and UTLs (EPA 1992, 2002b, and 2009). For data sets with non-detects (NDs), ProUCL has

several estimation methods including the Kaplan-Meier (KM) method, regression on order statistics (ROS) methods and substitution methods, for example replacing NDs by DL, DL/2.

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